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KIT9Z1J638EVM Evaluation Board

Featuring the MM9Z1J638 Intelligent Battery Sensor Module

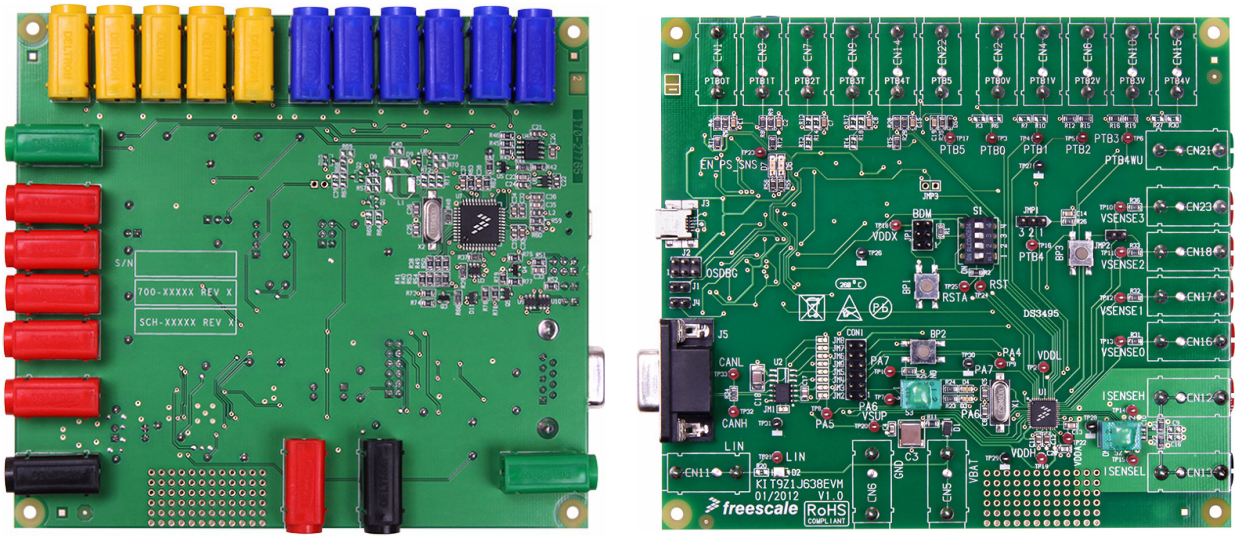

Figure 1. KIT9Z1J638EVM Evaluation Board

Contents

1 Kit Contents/Packing List 2
2 Jump Start 2
3 Important Notice 3
4 Introduction 4
5 Evaluation Board Features 4
6 MM9Z1J638 Device Features 6
7 Required Equipment 6
8 Evaluation Board Configuration 7
9 Setting Up and Using the Hardware and Software 8
10 Schematic 12
11 Board Layout 14
12 Bill of Material 18
13 References 21
14 Revision History 22

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1 Kit Contents/Packing List

- Assembled and tested evaluation board/module in anti-static bag.
- USB cable
- Warranty card

2 Jump Start

- Go to www.freescale.com/analogtools
- Locate your kit
- Review your Tool Summary Page
- Look for

- Download documents, software, and other information

3 Important Notice

Freescale provides the enclosed product(s) under the following conditions:

This evaluation kit is intended for use of ENGINEERING DEVELOPMENT OR EVALUATION PURPOSES ONLY. It is provided as a sample IC pre-soldered to a printed circuit board to make it easier to access inputs, outputs, and supply terminals. This evaluation board may be used with any development system or other source of I/O signals by simply connecting it to the host MCU or computer board via off-the-shelf cables. This evaluation board is not a Reference Design and is not intended to represent a final design recommendation for any particular application. Final device in an application will be heavily dependent on proper printed circuit board layout and heat sinking design as well as attention to supply filtering, transient suppression, and I/O signal quality.

The goods provided may not be complete in terms of required design, marketing, and or manufacturing related protective considerations, including product safety measures typically found in the end product incorporating the goods. Due to the open construction of the product, it is the user's responsibility to take any and all appropriate precautions with regard to electrostatic discharge. In order to minimize risks associated with the customers applications, adequate design and operating safeguards must be provided by the customer to minimize inherent or procedural hazards. For any safety concerns, contact Freescale sales and technical support services.

Should this evaluation kit not meet the specifications indicated in the kit, it may be returned within 30 days from the date of delivery and will be replaced by a new kit.

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4 Introduction

Freescale's KIT9Z1J638EVM is a hardware tool for evaluation and development. It is ideal for rapid prototyping of MCU-based applications for current, voltage and temperature sensing. The intelligent battery sensor MM9Z1J638 hardware, KIT9Z1J638EVM, is a simple, yet sophisticated design featuring an intelligent battery sensor with CAN and LIN.

KIT9Z1J638EVM can be used to evaluate the MM9Z1_638 family device. It features a MM9Z1J638, integrating a S12Z MCU and a SMARTMOS analog control IC into a single-package solution. The MM9Z1J638 enables precision measurement of key battery parameters, current, voltage and temperature. The acquisitions are run through three 16-bit sigma-delta ADCs embedded into the analog IC.

The MM9Z1J638 features a LIN protocol and physical interface compatible with LIN 2.0/2.1/2.2 requirements and MSCAN protocol controller and supply capability for 8 and 14 pin CAN interface.

The on-board interfaces include CAN, LIN. The CAN Physical Layer footprint allows to mount 8- or 14-pin CAN interface; the connection of the physical layer to MM9Z1J638 is done through jumpers to allow each configuration.

The KIT9Z1J638EVM is featuring Open Source BDM (OSBDM) providing low-speed debug communications to the S12Z core.

5 Evaluation Board Features

The KIT9Z1J638EVM evaluation board demonstrates the MM9Z1J638 multi-chip module IC. The board's main features are as follows:

- MM9Z1J638 intelligent battery sensor in a 48-QFN package with wettable flank
- High-speed CAN interface using MC33901, high-speed CAN transceiver and msCAN protocol layer embedded into the MM9Z1J638
- LIN interface
- Customizable GPIOs for voltage and temperature sensing
- LED indicators
- Onboard BDM connection via open source OSBDM circuit using the MC9S08JM60 MCU.
- Support for external BDM interface (for instance P&E USB Multilink BDM interface)

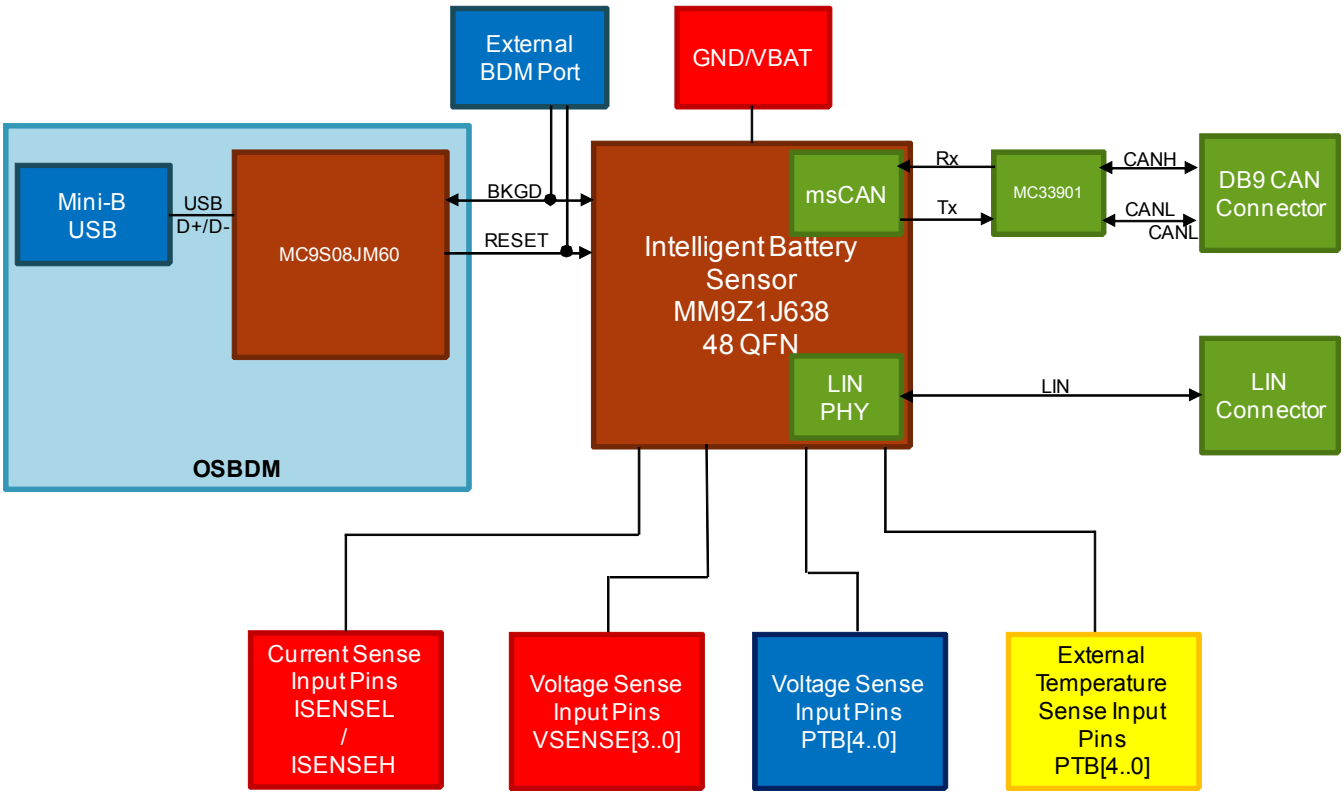


Figure 2. KIT9Z1J638EVM Block Diagram

6 MM9Z1J638 Device Features

The MM9Z1J638 is a fully integrated intelligent battery sensor device. The device supports precise current measurement via an external shunt resistor. It features four voltage measurements via an internal calibrated resistor divider or use of an external divider. Specific device functions include the following:

- Wide range battery current measurement; on-chip temperature measurement
- Four battery voltage measurements with internal resistor dividers, and up to five direct voltage measurements for use with an external resistor divider
- Measurement synchronization between voltage channels and current channels
- Five external temperature sensor inputs with internal supply for external sensors
- Low-power modes with low-current operation
- Multiple wake-up sources: LIN, timer, high-voltage input, external CAN interface, and current threshold and integration
- Precision internal oscillator and connections for external crystal
- LIN 2.2/2.1/2.0 protocol and physical interface
- MSCAN protocol controller, and supply capability for 8 and 14-pin CAN interfaces
- S12Z microcontroller with 128 kByte Flash, 8.0 kByte RAM, 4.0 kByte EEPROM

7 Required Equipment

Minimum equipment required:

- DC power supply with 12 V voltage capability and 300 mA current capability
- Oscilloscope (preferably four-channel)
- Digital multimeter
- USB-enabled PC with Windows XP or higher and **CodeWarrior** 10.x installed

8 Evaluation Board Configuration

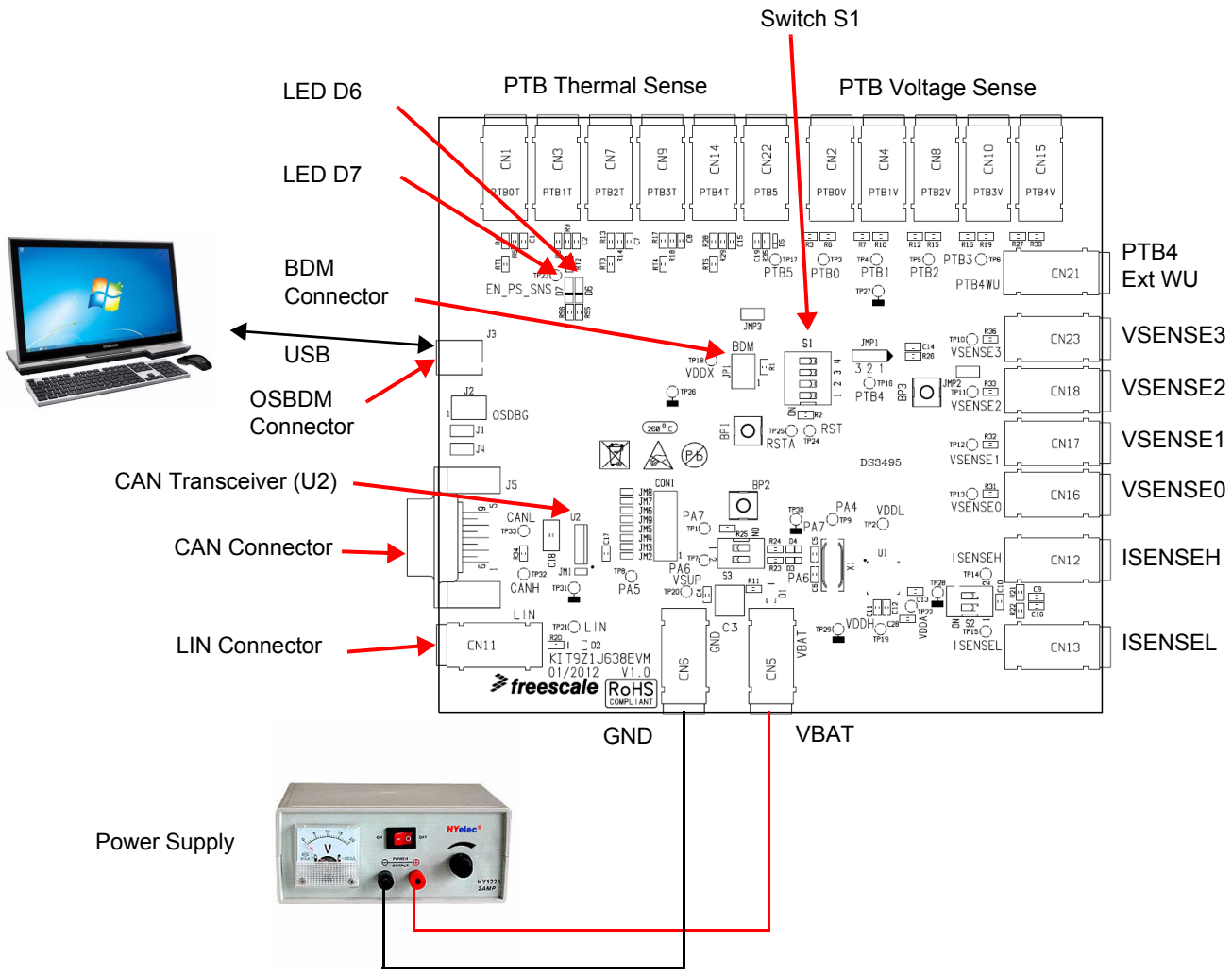


Figure 3. KIT9Z1J638EVM Board Setup

When using the OSBDM USB interface, set the following S1 switch settings:

When using the BDM connector, set the following S1 switch settings:

Figure 4. Switch S1 Settings

9 Setting Up and Using the Hardware and Software

In order to perform the demonstration examples, first setup the evaluation board hardware and software as follows:

1. Download **CodeWarrior** 10.4 or higher, using the instructions in the "Jump Start" section.
2. Install **CodeWarrior** Suite on to a USB-enabled PC running Windows XP or higher.
3. Connect the USB cable from the OBSDM port on the evaluation board to computer.
4. Without turning on the power, connect the positive voltage output (set for +12V) of the DC power supply to the VBAT terminal on the board (schematic label CN5). Connect the ground line from the supply to the GND terminal on the board (CN6).
5. Launch the **CodeWarrior** Suite.
6. Turn on the power supply.
7. Start development of your application using **CodeWarrior**.

Notes:

1. Notice on the EVM, for proper operation connect RESET to RESETA, by setting pin 1 of the S1 Switch ON. The S1 switch is not always set, because when flashing the part, there is flow between the reset drive from the BDM interface and the reset from the analog die (through the watchdog). A workaround is to add a 470 nF capacitor between RESET and GND on the BDM interface. This prevents resets while flashing. Disconnecting both pins through the switch S1-1 on KIT9Z1J638EVM avoids this workaround.
2. The RESET pin of the MM9Z1J638 is a reset Input/Output pin of the embedded MCU, so when hitting BP1, the embedded MCU will be reset. RESETA pin of MM9Z1J638 is a reset output (when in normal mode), so setting RESETA pin to 0 will not reset the analog die. This must be done through the HWR bit of the PCR_CTL register. Each time there is a RESET of the MCU, check that the HWRF bit is set. If not, a command reset to the analog die through HWR of PCR_CTL is needed.

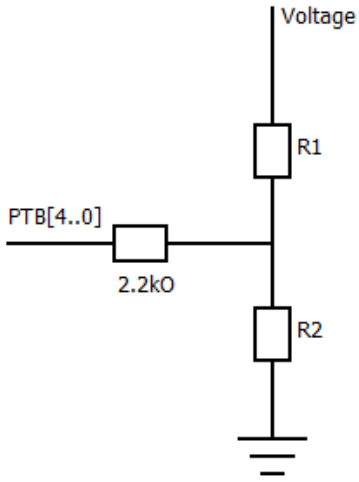
9.1 GPIO Setup

The KIT9Z1J638EVM is offering a customizable set of general purpose IOs for measurement of external temperature or voltage through the dedicated 16-bit sigma-delta ADCs of the MM9Z1J638, intelligent battery sensor.

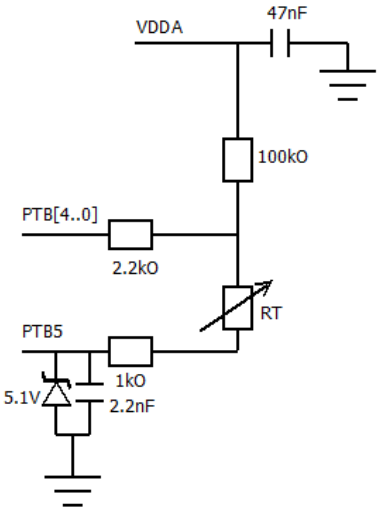
The customization must be performed by setting the right set of components on the selected PTB. Footprints and dedicated banana connectors are available on the board to customize the KIT9Z1J638EVM according to your application needs.

- PTB[3…1] can also be set as 5.0 V IOs which might be connected to TIMer and/or SCI (UART) modules.
- PTB4 can be set as a 5.0 V input and offers extra functionalities such as a CAN wake-up pin and high voltage wake-up input pin.
- PTB5 is a ground switch and is used while monitoring external temperatures to minimize power consumption.

Refer to the schematics in Figure 5.



PTB[4…0] Voltage Sensing External Divider with R1 and R2



PTB[4…0] External Temperature Sensing Thermistor RT

Figure 5. Using GPIOs as Voltage Sense or External Temperature Sense Inputs

Refer to the MM9Z1_638D1 data sheet for further information regarding voltage and external temperature sensing. Refer to Figure 8 for the component for every GPIO.

Refer to Assembly Layer Top for the localization of components and footprint on the KIT9Z1J638EVM.

Note: GPIO pins might also be connected to OSBDM to set Serial to the USB port. This is done by connecting:

TxD from SCI to one pin out of PTB[3…1], then the selected PTB to JP4-2.

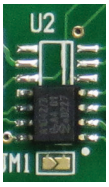
RxD from SCI to one pin out of PTB[4…1], then the selected PTB to JP4-1.

Insure that the two selected PTB pins have no other setting (voltage sensing external divider, external temperature sensing setup), which might conflict with the 5.0 V digital IO setup.

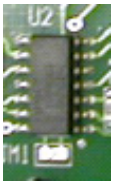
9.2 CAN Configuration

The KIT9Z1J638EVM board comes with an 8-pin high-speed CAN transceiver MC33901, mounted in the U2 position.This transceiver is configured using jumpers JM1 to JM9.

The KIT9Z1J638EVM is highly configurable to set the product within the configuration closest to designer needs, and showcases the versatility of the MM9Z1_638 product. It allows using an 8-pin (without SPLIT pin version) or a 14-pin CAN transceiver as a CAN transceiver. This is done by setting the device in the U2 position on the board, according to Figure 6, and to connect pins through the jumpers as shown in Figure 7.



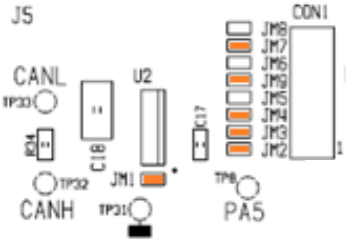
U2 mounted with 8-pin CAN transceiver



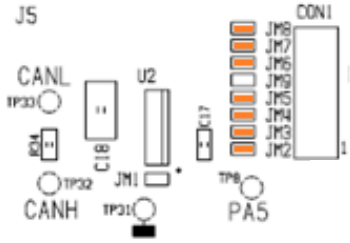
U2 mounted with 14-pin CAN transceiver

Figure 6. CAN Transceiver Placement

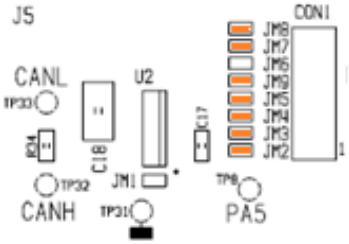
The connection between CAN transceiver is configured using the jumpers JM1 to JM9. There is one configuration for 8 pins and two for 14 pins.



8-pin CAN operation



14-pin CAN operation: Low-power mode = sleep mode on MM9Z1J638 - WU through INH



14-pin CAN operation: Low-power mode = stop mode on MM9Z1J638 - WU through RxD

Note: Jumpers in orange have to be connected for proper operation

Figure 7. CAN Jumper Connections

9.3 Hardware Description

This evaluation kit features one MM9Z1J638 (intelligent battery sensor), one MC33901 (high-speed CAN Interface), and one MC9S08JM60CQH (OSBDM debug interface). The board-level logic diagram is show in Figure 2.

9.4 LED Display

The following LEDs are provided as visual output devices for the KIT9Z1J638EVM evaluation board:

1. LED D3 indicates when switch S3-2 is ON and PA6 is set to 5.0 V
2. LED D4 indicates when switch S3-1 is ON and PA7 is set to 5.0 V
3. LED D6 indicates when OSBDM is powered by a USB cable
4. LED D7 indicates when OSBDM is connected to the MM9Z1J638 through S1-2, S1-3, S1-4, and the MM9Z1J638 is powered through VBAT and GND connections

9.5 Test Point Definitions

The following test-point jumpers provide access to signals on the KIT9Z1J638EVM IC:

Table 1. Test Point Jumpers and Description

Test Point Number	Description
TP1	PA7
TP2	VDDL
TP3	PTB0
TP4	PTB1
TP5	PTB2
TP6	PTB3
TP7	PA6
TP8	PA5
TP9	PA4
TP10	VSENSE3
TP11	VSEMSE2
TP12	VSENSE1
TP13	VSENSE0
TP14	ISENSEH
TP15	ISENSEL
TP16	PTB4
TP17	PTB5
TP18	VDDX
TP19	VDDH
TP20	VSUP
TP21	LIN
TP22	VDDA
TP23	ELE_PS_SENSE
TP24	RESET
TP25	RESETA
TP26	GND
TP27	GND
TP28	GND
TP29	GND
TP30	GND
TP31	GND
TP32	GND
TP33	GND
TP34	GND
TP35	CANH
TP36	CANL

10 Schematic

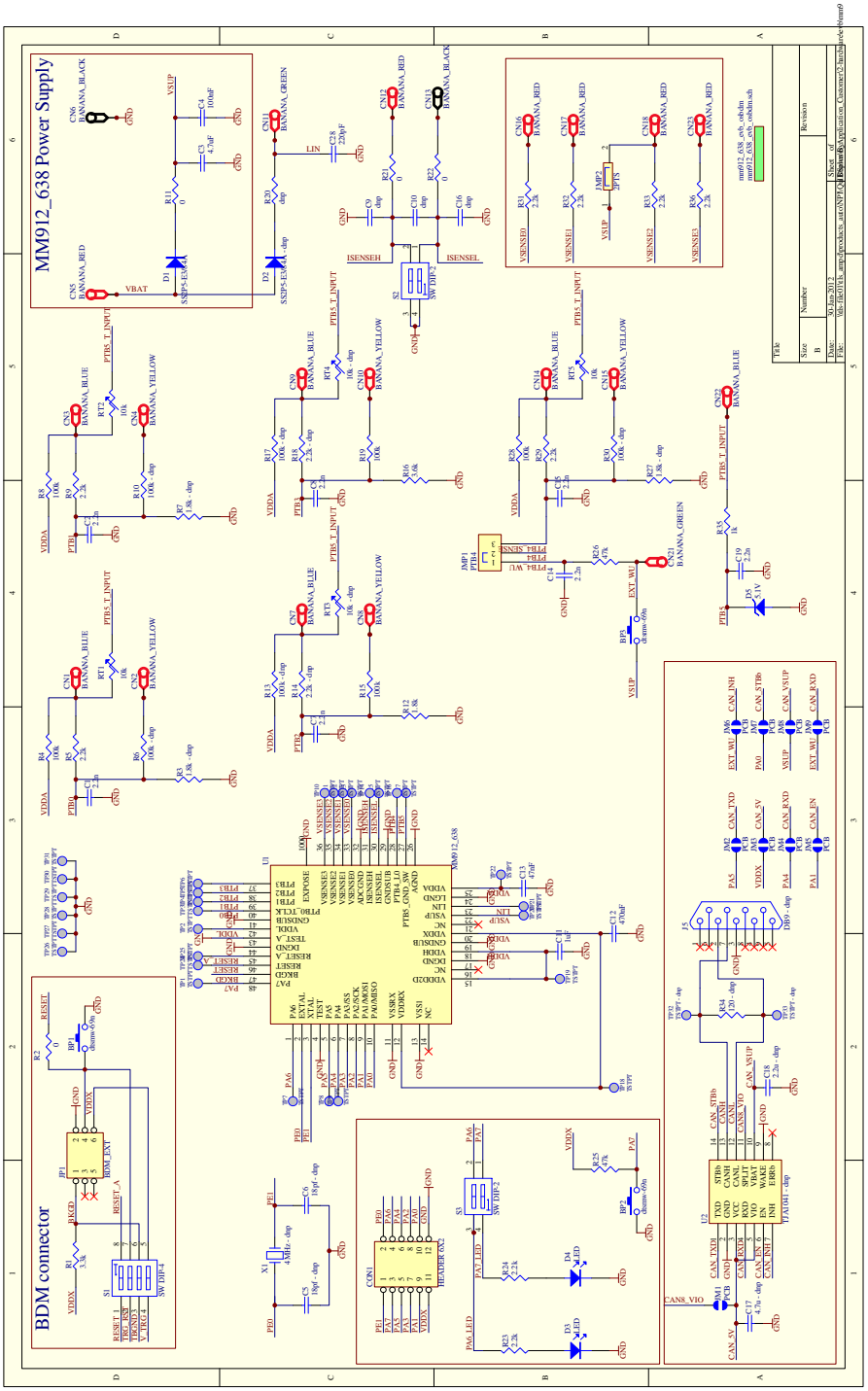


Figure 8. Evaluation Board Schematic, Part 1

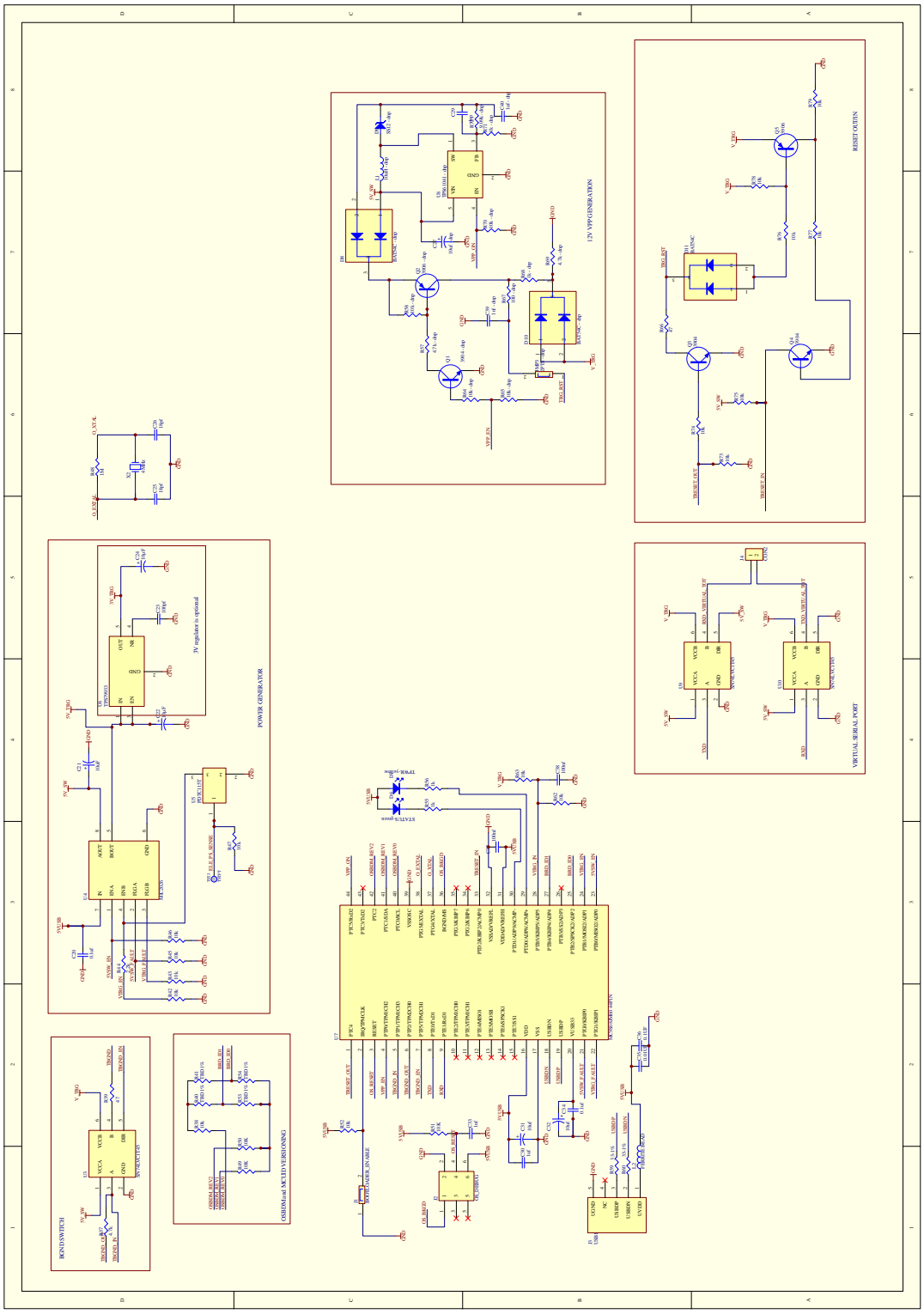
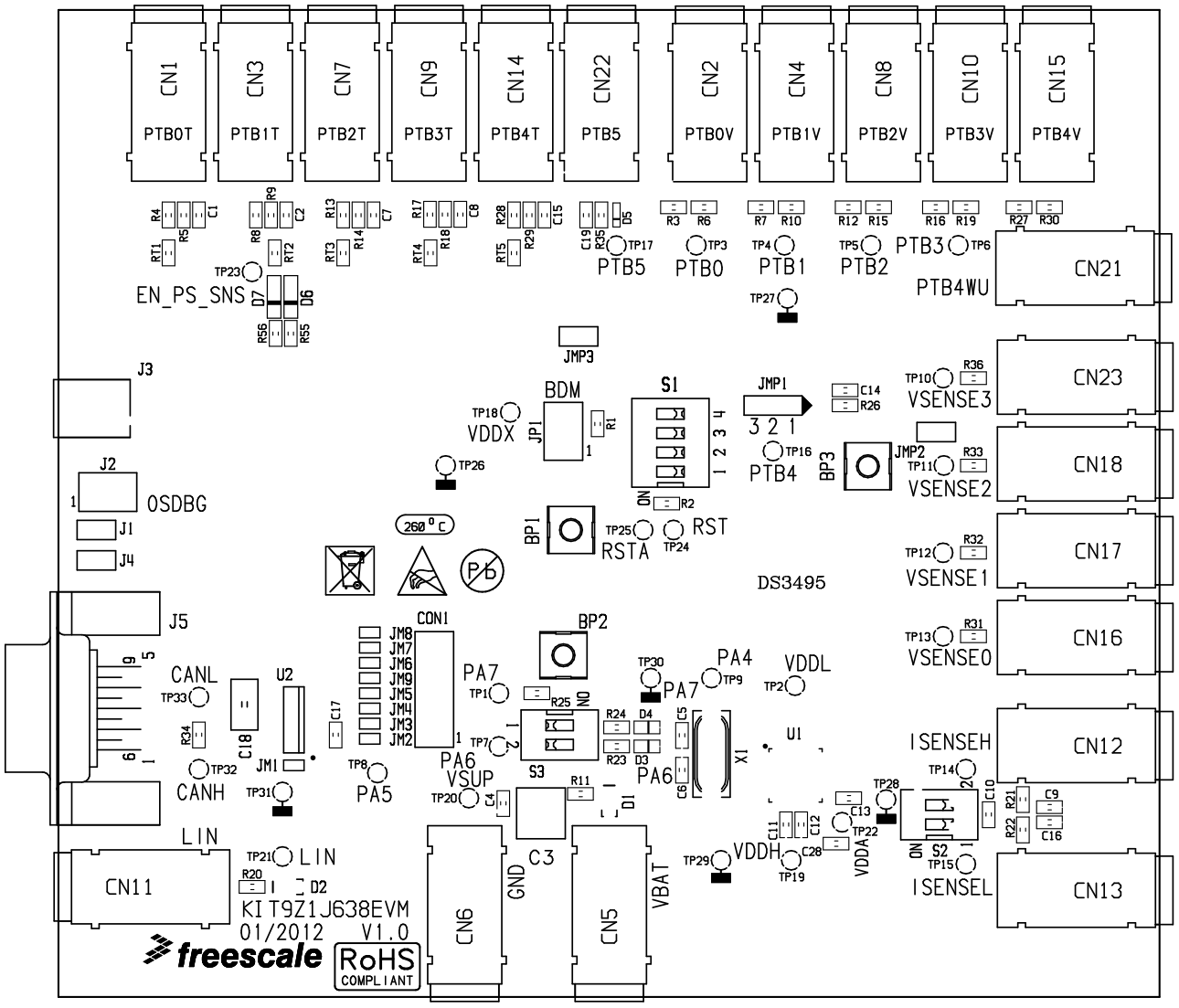


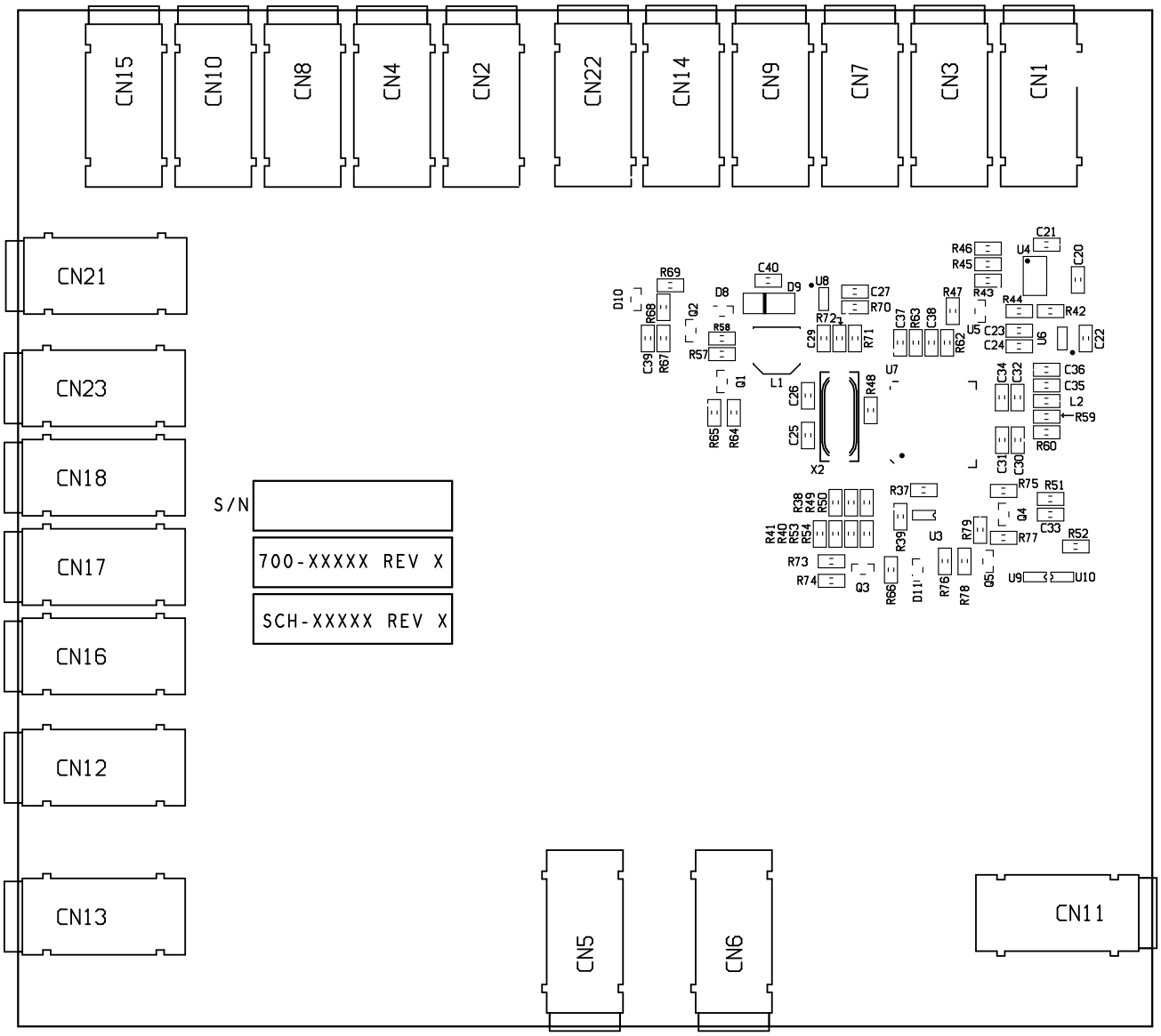
Figure 9. Evaluation Board Schematic, Part 2

11 Board Layout

11.1 Assembly Layer Top

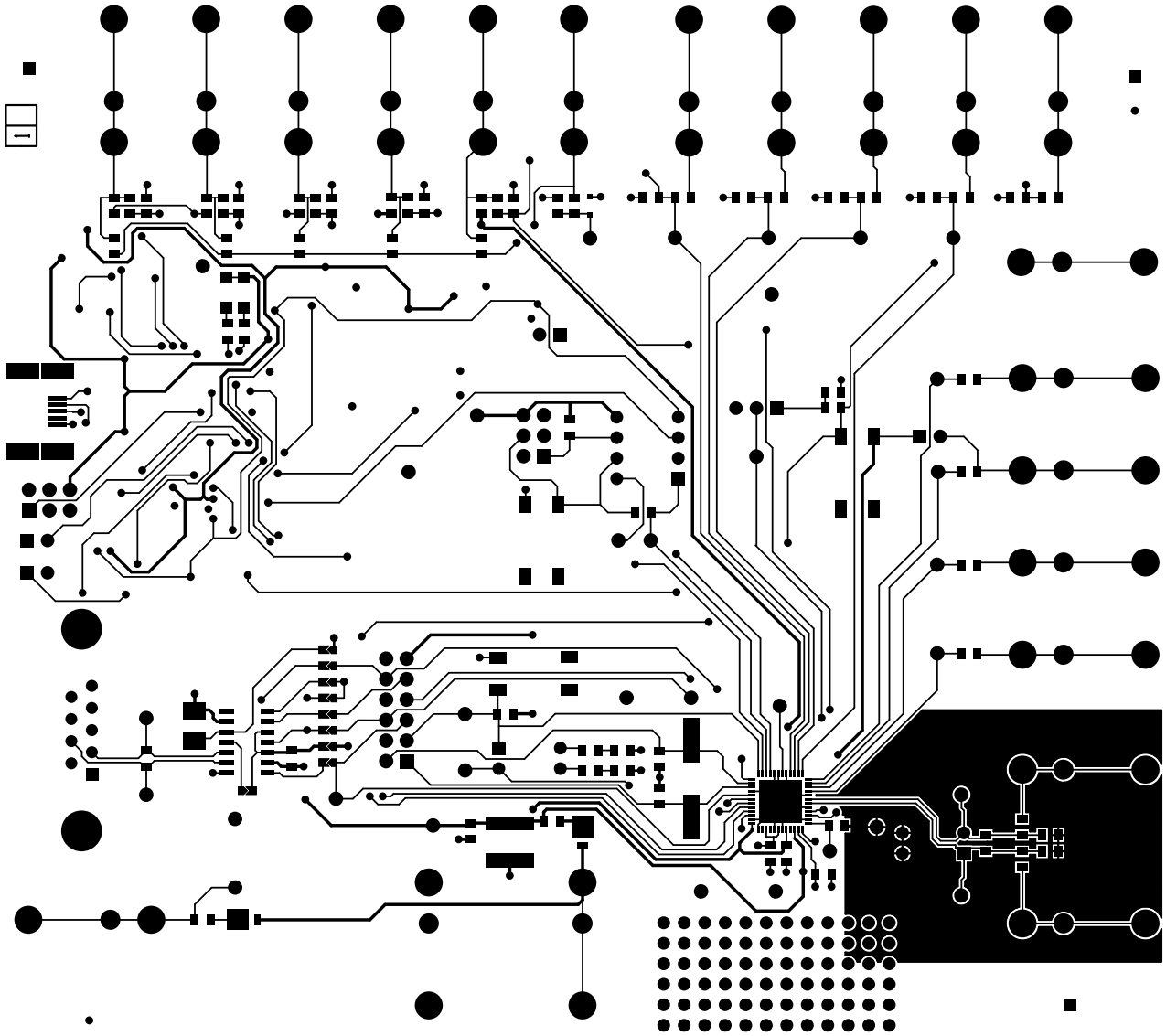


11.2 Assembly Layer Bottom

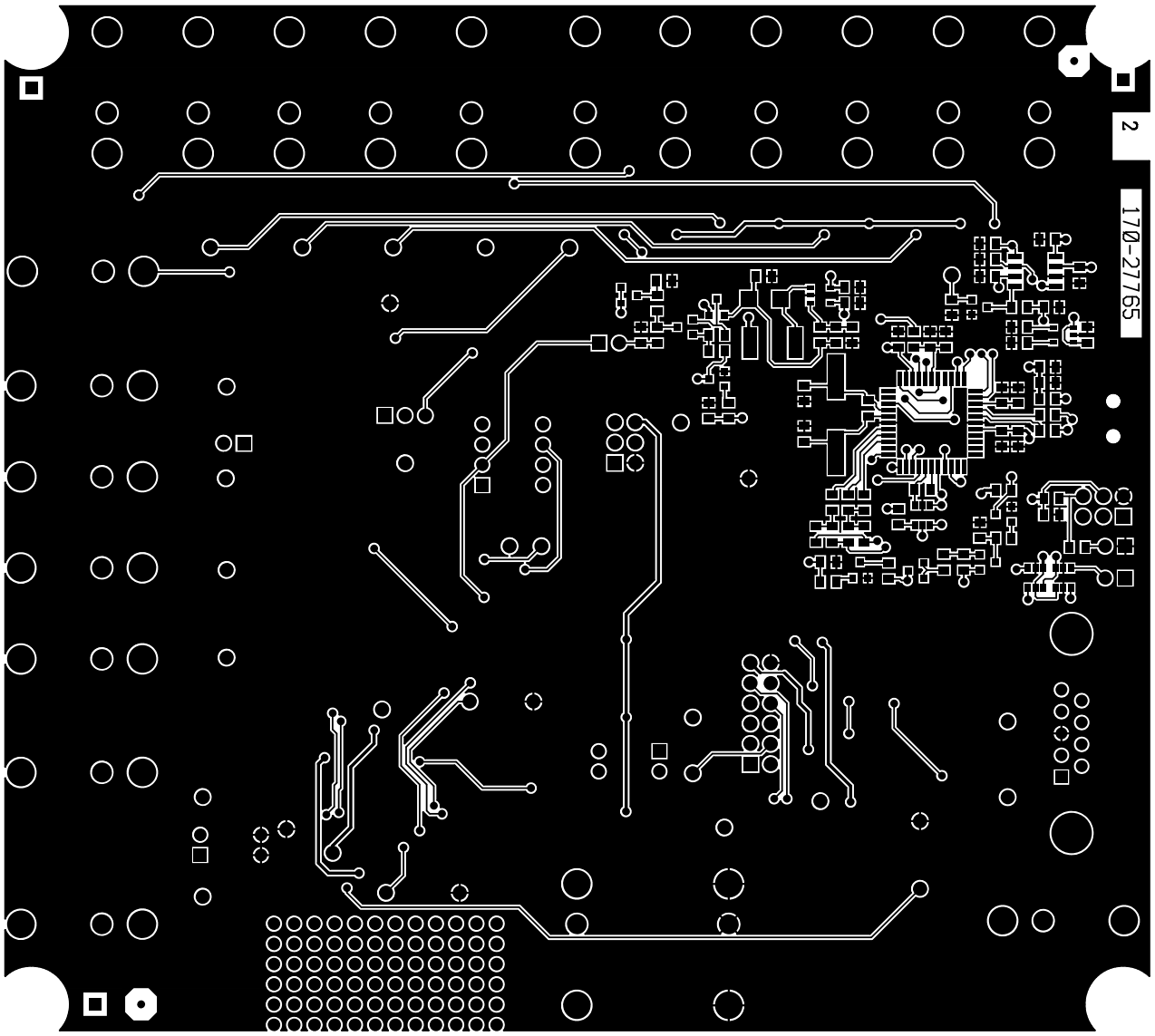


Note: This image is an exception to the standard top-view mode of representation used in this document. It has been flipped to show a bottom view.

11.3 Top Layer Routing



11.4 Bottom Layer Routing



Note: This image is an exception to the standard top-view mode of representation used in this document. It has been flipped to show a bottom view.

12 Bill of Material

Table 2. Bill of Material (1)

Schematic Label	Quantity	Assy. Opt.	Value	Description	Package
Integrated Circuits					
U1	1	(2)		Freescale MM912J638BM2EP	QFN48LD-EP
U2	1			Freescale MC33901WEF (SO-8)	SO-14
U3	1			SN74LVC1T45DBVR	SOT-23-6
U4	1			MIC2026-1YM	SOIC-8
U5	1			PDTC115T	SOT-23
U6	1			TPS79933	TSOT-23−5
U7	1	(2)		Freescale MC9S08JM60CQH	QFP44
U8	1	DNP (3)		TPS61041	SOT-23-5
U9, U10	2			SN74LVC1T45	SOT-23-6
Crystal Oscillators					
X1, X2	2		4.0 MHz	4.0 MHz HC-49/SMT	HC-49 SMD
Transistors					
Q1	1	DNP (3)		MMBT3904	SOT-23
Q2	1	DNP (3)		MMBT3906	SOT-23
Q3, Q4	2			MMBT3904	SOT-23
Q5	1			MMBT3906	SOT-23
Diodes (including LEDs)					
D1, D2	2			SS2P5-E3/84A	SMP
D3, D4	2			HSMH-C170	D0805
D5	1		5.1 V	BZX384-C5V1,115	SOD323
D6	1			STATUS GREEN	D1206
D7	1			TPWR YELLOW	D1206
D8	1	DNP (3)		BAT54C, 215	SOT-23
D9	1	DNP (3)		SS12	DO-214AC (SMA)
D10	1	DNP (3)		BAT54C	SOT-23
D11	1			BAT54C	SOT-23
Capacitors					
C1, C2, C7, C8, C14, C15, C19	7		2.2 nF	50V Capacitor	C0805
C3	1		4.7 µF	100V Capacitor	c2220
C4, C37, C38	3		100 nF	50V Capacitor	C0805
C5, C6, C25, C26	4		18 pF	50V Capacitor	C0805
C9, C10, C16, C29	4	DNP (3)	—	DNP Capacitor	C0805
C11, C30	2		1.0 µF	50V Capacitor	C0805
C12	1		470 nF	100V Capacitor	C0805
C13	1		47 nF	100V Capacitor	C0805
C17	1		4.7 µF	16V Capacitor	C0805
C18	1		2.2 µF	100V Capacitor	C1210
C20, C34, C36	3		0.1 µF	50V Capacitor	C0805

Table 2. Bill of Material (continued) [1]

Schematic Label	Quantity	Assy. Opt.	Value	Description	Package
C21, C22, C24, C31, C32	5		10 µF	10V Capacitor	C0805
C23	1		100 pF	50V Capacitor	C0805
C27	1	DNP [3]	10 µF	10V Capacitor	C0805
C28	1		220 pF	100V Capacitor	C0805
C33	1		1.0 nF	50V Capacitor	C0805
C35	1		0.01 µF	100V Capacitor	C0805
C39, C40	2	DNP [3]	1.0 nF	50V Capacitor	C0805
Inductors					
L1	1	DNP [3]	10µH	Choke Coil ELL6SH100M	
L2	1			Ferrite Bead BLM21PG331SN1D	L0805
Resistors					
R1	1		3.3 k	Resistor	R0805
R2, R11, R21, R22, R54	5		0	Resistor	R0805
R3, R7, R27	3	DNP [3]	1.8 k	Resistor	R0805
R4, R8, R15, R19, R28	5		100 k	Resistor	R0805
R5, R9, R23, R24, R29, R31, R32, R33, R36, R44	10		2.2 k	Resistor	R0805
R6, R10, R13, R17, R30	5	DNP [3]	100 k	Resistor	R0805
R12, R53	2		1.8 k	Resistor	R0805
R14, R18	2	DNP [3]	2.2 k	Resistor	R0805
R16	1		3.6 k	Resistor	R0805
R20	1		DNP	Resistor	R0805
R25, R26	2		47 k	Resistor	R0805
R34	1		120	Resistor	R0805
R35, R55, R56	3		1.0 k	Resistor	R0805
R37	1		4.7 k	Resistor	R0805
R38	1		10 k	Resistor	R0805
R39, R66	2		47	Resistor	R0805
R40, R41, R42, R43, R45, R46, R47, R49, R50, R51, R52, R62, R63, R73, R74, R75, R76, R77, R78, R79	20		10 k	Resistor	R0805
R48	1		1.0 M	Resistor	R0805
R57, R69	2	DNP [3]	4.7 k	Resistor	R0805
R58, R64, R65, R70	4	DNP [3]	10 k	Resistor	R0805
R59, R60	2		33	Resistor	R0805
R67	1	DNP [3]	100	Resistor	R0805

Table 2. Bill of Material (continued) [1]

Schematic Label	Quantity	Assy. Opt.	Value	Description	Package
R68, R71	2	DNP [3]	1.0 k	Resistor	R0805
R72	1	DNP [3]	9.09 k	Resistor	R0805
RT1, RT2, RT5	3		10 k	Thermistor	R0805
RT3, RT4	2	DNP [3]	10 k	Thermistor	R0805
Switches, Connectors, Jumpers and Test Points					
BP1, BP2, BP3	3			Tactile Switch DTSMW-69N	DTSMW69
S1	1			SWITCH	DIP-8
S2, S3	2			SWITCH	DIP-4
CN1, CN3, CN7, CN9, CN14, CN22	6			BANANA BLUE	Banana connector 4.0 mm
CN2, CN4, CN8, CN10, CN15	5			BANANA YELLOW	Banana connector 4.0 mm
CN5, CN12, CN16, CN17, CN18, CN23	6			BANANA RED	Banana connector 4.0 mm
CN6, CN13	2			BANANA BLACK	Banana connector 4.0 mm
CN11, CN19, CN20, CN21	4			BANANA GREEN	Banana connector 4.0 mm
CON1				HEADER CON 6x2 2.54mm	
J1	1			JUMPER CON 2 2.54mm (BOOTLOADER_ENABLE)	
J2	1			JUMPER CON HE-10 6 MD (OS_DEBUG)	
J3	1			USB Connector 5P MINI TYPE B RECPT	SMT WITH POSTS
J4	1			JUMPER CON 2 2.54mm	
J5	1			CONNECTOR DB9 Female	
JM1 - JM9	9			JUMPER PCB	
JMP1	1			JUMPER PTB4 CON 3 2.54mm	
JMP2, JMP3	2			JUMPER 2PTS CON 2 2.54mm	
JP1	1			JUMPER CON HE-10 6 MD (BDM_EXT)	
TP1 - TP33	33			TSTPT 5000	

Notes

1. Freescale does not assume liability, endorse, or warrant components from external manufacturers that are referenced in circuit drawings or tables. While Freescale offers component recommendations in this configuration, it is the customer's responsibility to validate their application.
2. Critical Components. For critical components, it is vital to use the manufacturer listed.
3. DNP = Do not populate

13 References

Following are URLs where you can obtain information on related Freescale products and application solutions:

Freescale.com Support Pages	Description	URL
KIT9Z1J638EVM	Tool Summary Page	http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=KIT9Z1J638EVM
MM9Z1J638	Product Summary Page	http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=MM9Z1_638
MM9Z1_638	Data Sheet	http://www.freescale.com/files/analog/doc/data_sheet/MM9Z1_638D1.pdf
Analog Home Page	Home Page	http://www.freescale.com/analog
Battery Home Page	Home Page	http://www.freescale.com/battery
OSBDM Source Code	Home Page	http://www.pemicro.com/osbdm

13.1 Support

Visit www.freescale.com/support for a list of phone numbers within your region.

13.2 Warranty

Visit www.freescale.com/warranty for a list of phone numbers within your region.

14 Revision History

Revision	Date	Description of Changes
1.0	3/2014	• Initial Release

RoHS

How to Reach Us:

Home Page:
freescale.com

Web Support:
freescale.com/support

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